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Abstract

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INSTRUCTIONAL OBJECTIVES FOR A JUNIOR COLLEGE COURSE IN PHYSICS (FIRST SEMESTER)

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PHYSICS OBJECTIVES: SET #1

UNIT 1 - INTRODUCTION AND MATHEMATICAL REVIEW

Science plays a significant role in shaping today's world events. Physics is a basic science concerned with understanding the nature of physical reality and has helped to make possible the technological changes occurring in the world today. Prior to consideration of the subject matter, the student should acquaint himself with the methods used by the physicist in developing concepts of "physical truth". The student must also review some basic mathematics which are necessary for an understanding of the material in this course.

Objectives

I. General — The student will become familiar with the procedures used by the physicist in his investigations.

Specific

1.—The student will explain in 25 words or less what is meant by a "law" in physics.

2.—He will list the six basic procedures of the "scientific method" which have in general guided the past activities of the scientific worker and in ten words or less specify the one characteristic which differentiates the "scientific method" from the investigations of Aristotle's time.

3.—He will describe in 25 words or less what is meant by a "physical model" in physics and how "models" can change.

II. General — The student will be able to use the elements of algebra and trigonometry in problem solving.

Specific

4.—Given a group of 10 problems involving simple linear algebraic equations and calculations involving operations with exponents, he shall solve the problems with 90% accuracy in 20 minutes. A sample of the problems is contained in the Sample Test Items shown below.

5.—Without the aid of any reference material, the student will define the meaning of the basic trigonometric functions, sine, cosine and tangent with relation to a right triangle, define the Pythagorean theorem and solve accurately 5 of 6 problems accurately in 20 minutes involving trigonometric functions and the use of the Pythagorean theorem. A sample of the problem is contained in the Sample Test Items shown below.

6.—The student will solve problems 10, 12, 14, 16, 18, 20, 22, 32, 42, 44, 46, 48 in Van Name, Chapter 1.

UNIT 2 - DESCRIBING MOTION

One of the most readily observed phenomena in the physical world is the motion of objects. It is appropriate to begin the study of Physics with an analysis of the simplest kind of motion normally encountered.

Objectives

I. General — The student will understand the meaning of the fundamental terms used in describing the motion of bodies.

Specific 1.-The student will define the following terms in 10 words or less for each term; displacement, speed, velocity, acceleration.

2.-He will distinguish between (a) scalar and vector quantities (b) instantaneous and average speeds in 25 words or less for each of the pairs of terms.

3.-Given data of the position - time history of a body in motion, the student will be able to graph the data and obtain from the graph values of the velocity and acceleration at any instant of time.

II. General — The student will become familiar with the fundamental algebraic operations with vectors.

Specific 4.-Given 6 problems involving vector multiplication, vector addition and vector subtraction, the student will solve accurately 5 of the 6 problems without the use of any reference material within 30 minutes.

III. General — The student will know how to use the equations of uniformly accelerated motion.

Specific 5.-The student will solve problems 4, 6, 7, 8, 9 in Van Name. Ch.2

IV. General — The student will understand the application of the equations of constant acceleration to falling bodies.

Specific 6.-The student will in 50 words or less describe Galileo's discovery about falling bodies and the significance of his discovery in the history of scientific thought.

7.-The student will state the value of the acceleration of gravity near the earth's surface.

UNIT 3 - FORCE AND MOTION

Description of Motion was presented in Unit 2. An understanding of motion requires knowing what produces motion initially, why some bodies are accelerated and others not and what factors are involved in the world around us that produce the physical phenomena we observe.

Objectives

I. General — The student will know Newton's 3 laws of motion.

Specific

1.-The student will state in 50 words or less, Newton's 3 laws of motion.

2.-The student will provide two examples illustrative of each law by describing them in 10 words or less for each example, as they exist in his physical environment.

3.-He will express Newton's 2nd law in the form of an equation.

4.-He will distinguish between (a) mass and weight, (b) gravitational mass and inertial mass in 25 words or less for each pair of terms.

II. General — The student will know the basic quantities in the English and metric systems of units.

Specific

5.-The student will specify the units of mass, length and time in the Mks System.

III. General — The student will understand the role of frictional forces and how they affect motion.

Specific

6.-The student will state the two factors governing the magnitude of frictional forces.

7.-The student will give three examples of frictional forces existing in his physical environment involving the motion of bodies.

8.-The student will give three examples of frictional forces existing in his physical environment in which the bodies are not in motion.

9.-The student will describe in 10 words or less, the meaning of static equilibrium.

10.-The student will solve problems 13, 15, 20, 21, 33, 34, 38 in Van Name, Chapter 2.

11.-Without the use of any reference material, the student will solve 8 out of 10 problems with 100% accuracy within 30 minutes similar to those shown in Sample Test Items shown below.

UNIT 4 -- CIRCULAR MOTION AND GRAVITATION

Physical nature abounds with examples of bodies moving in circular or near circular motion. The orbits of the earth and planets around the sun and moon are very nearly circular; a convenient model of the atom assumes circular motion of electrons about a central nucleus. An understanding of circular motion is essential for the study of gravitation.

Objectives

I. General — The student will become familiar with the principles of circular motion.

Specific

1.-The student will, in 25 words or less, define uniform circular motion and give three examples in his physical environment of uniform circularmotion.

2.-He will be able to explain, in 50 words or less, why centripetal force is necessary for a body to move in a curved path and give two examples in his physical environment of phenomena involving centripetal force.

3.-The student will be able to state in 10 words or less, the relationship between the centripetal acceleration of a body undergoing uniform circular motion and the velocity and radius of its path.

4.- He will distinguish between centripetal & centrifugal forces.

II. General — The student will understand the relationship of circular motion of heavenly bodies to gravitational phenomena.

Specific

5.-The student will, in 50 words or less describe how Newton related gravitational attraction between two heavenly bodies to the circular orbital motion of these bodies.

6.-He will, in one sentence, be able to state Newton's law of universal gravitation and write an equation representing this law.

7.-He will give three examples of physical phenomena which suggests gravitation to be a universal phenomena.

8.-The student will, in 100 words or less, describe the Lord Cavendish experiment to evaluate the gravitational constant and how it is used in calculating the mass of the earth.

III. General — The student will become familiar with the representation of gravitational phenomena in terms of a gravitational "field".

Specific

9.-The student will distinguish in 25 words or less "direct contact forces" and "action at a distance forces."

Specific 10.-Given the equation for Newton's second law of motion the student will derive the impulse-momentum relationship within 5 minutes or less and without the use of any reference material.

11.-The student will in 25 words or less state the principle of the conservation of linear momentum.

12.-The student will in 100 words or less describe the mechanics of rocket flight in terms of conservation of momentum.

IV. General The student will understand how collisions between interacting bodies can be analyzed using conservation of momentum principles.

Specific 13.-The student will in one or two sentences distinguish between elastic and inelastic collisions.

14.-Energy and momentum are entirely independent concepts. The student will give an example in 100 words or less of two interacting bodies where momentum is conserved but Kinetic energy is not.

15.-The student will solve problems 16, 17, 18, 19, 22, 23, 39, 40, 42, 43, 44, 52, 53, 54 - Chapter 2 - Van Name.

16.-Without the use of the textbook, the student will solve 8 out of 10 problems with 100% accuracy (in 30 minutes) similar to those shown in Sample Test Items Section for this unit.

UNIT 6 - HEAT

One of the most obvious environmental phenomena relative to our physical senses is heat and cold. Historically, this subject has had a very dramatic past and is linked very closely with some problems in the forefront of physics today. The macroscopic point of view of heat and thermal phenomena need first to be explored to serve as a background for the more complicated explanation of heat in terms of the microscopic structure and behavior of matter which are treated in Unit 7.

Objectives

I. General The student will know the fundamentals of heat.

Specific 1.--The student will, in one or two sentences, distinguish between temperature and heat.

2.--He will in 100 words or less, describe how temperature scales are established and specify two temperature scales used widely in both science and industry.

3.--He will in one sentence state what is meant by the specific heat of a substance.

4.--The student will solve problems 1, 2, 5, 6, 7 - Van Name, Chapter 3.

II. General The student will know some fundamental concepts in thermodynamics.

Specific 5.--The student will in 50 words or less, state what is meant by the mechanical equivalent of heat and give its numerical value in metric units.

6.--The student will in 50 words or less, show how the first law of thermodynamics is related to the conservation of energy.

7.--He will in 50 words or less give two alternative statements of the 2nd law of thermodynamics.

8.--He will, in 25 words or less, indicate the significance of the 2nd law of thermodynamics in terms of energy conversion.

9.--The student will solve problems 8, 9, 10, 11 - Van Name, Chapter 3.

10.--Without the use of a reference text, he will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items section for this unit.

UNIT 7 - PROPERTIES OF GASES, LIQUIDS, SOLIDS

Thus far, we have been considering laws and principles underlying the more conspicuous behavior of bodies. These bodies consist of microscopic aggregates of matter. However, we have not touched upon the microscopic properties of the aggregates themselves - what they are composed of, what their structure is and how their internal character is related to their interactions with the external world. It is necessary to look into the realm of molecules, the first step in an exploration of the microscopic universe.

Objectives

I. General — The student will know some of the general properties of matter.

Specific

1.--The student will specify the three states of matter and give one example of each.

2.--The student will, in 50 words or less, distinguish between elements, compounds, and solutions.

3.--The student will in one sentence, state what is meant by the coefficient of linear expansion.

4.--The student will, in one sentence, state what is meant by the coefficient of volume expansion and give a general equation relating the coefficient of linear expansion to the coefficient of volume expansion.

II. General — The student will understand the effect of heat on the state of substances.

Specific

5.--The student will define in one sentence each, what is meant by the following terms: heat of fusion, heat of vaporization, sublimation.

6.--Experimentally it has been determined that change of state is dependent upon pressure. The student will describe in 50 words or less, what is meant by pressure and distinguish between absolute and gauge pressure.

7.--He will state, in 50 words or less, what is meant by the critical point and the significance of the critical point in the state of a substance.

III. General — The student will know the behavior of gases under the influence of changing pressure, temperature and volume.

Specific 8.-The student will be able to in 100 words or less, describe Boyles law and Charles law and how they are combined to yield the ideal gas law.

9.-The student will be able, in 50 words or less, describe how the absolute temperature scale is derived using the experimentally observed fact that the coefficient of volume expansion is essentially the same for all gases at 0° C.

10.-The student will solve problems 12, 14, 17, 18, 20, 21.

IV. <u>General</u> The student will know the elements of the molecular theory of matter and how the kinetic theory of gases derives from it.

Specific 11.-The student will distinguish between atoms and molecules.

12.-The student will in 25 words or less describe what is meant by atomic weight and molecular weight and how the fundamental atomic weight unit is derived.

13.-The student will in 25 words or less give the three assumptions upon which the kinetic theory of gases is based.

14.-The student will be able to describe in 100 words or less, ~~and using the appropriate equations~~, how the ideal gas law is derived from the kinetic theory of gases.

15.-The student will describe in 25 words or less, how absolute zero is interpreted in terms of the kinetic theory of gases.

16.-Without the use of a reference test, the student will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items for this unit.

UNIT 8 - ELECTRICITY

Electrical Phenomena is manifested all about us. A study of the elements of electricity is essential to an understanding of this aspect of our universe.

Objectives

I. General — The student will understand the basic characteristics of electrical charge.

Specific 1.- He will be able to describe in 100 words or less two classic experiments, demonstrated in class, to produce negative and positive electrical charges and what the mechanism is for the production of these charges.

2.- He will be able to describe in 100 words or less, the two experiments leading to the specification of the forces existing between charged particles in terms of the magnitude of the charges and the distance separating the charges. He will state this relationship in the equation known as Coulomb's law.

3.- He will be able to explain, in one sentence, how a charged object can attract an uncharged object.

4.- He will describe in 100 words or less, the two general methods for electrically charging a body; by conduction and by induction.

II. General — The student will understand what is meant by an electric field.

Specific 5.- The student will describe in 25 words or less what is meant by "electric field" and give the mathematical expressions for electric field intensity.

6.- He will draw a representation of an electric field around a point charge, using the lines of force concept and explain in one sentence the significance of the direction of the lines and the spacing of the lines.

7.- Using the equations of electric field intensity and Coulomb's law, he will be able to calculate the magnitude of the field intensity at any position in space due to a given charge.

III. General — The student will understand Millikan's oil drop experiment to determine the fundamental charge of electricity.

Specific 8.- He will describe in 100 words or less, Millikan's oil drop experiment and give the justification for believing that electrical charges are multiples of a minimum individible charge.

9.- Given Coulomb's Force law and Newton's Gravitational law, the student will be able to show by calculations that the gravitational force between two charged particles are trivial in comparison to the electrical forces.

IV. General The student will know how the concepts of work and potential energy are used in studying electrical phenomena and what is meant by potential difference.

Specific 10.- The student will explain in 50 words or less what is meant by potential difference between two points in an electric field, relating the potential difference to the work done in moving a unit charge in an electric field.

11.- He will specify in 50 words or less what an electron volt is and how to convert energy expressed in joules to electron volts and vice versa.

V. General The student will become acquainted with some of the principles of electrical currents.

Specific 12.- In 10 words or less, student will explain what is meant by electric current and what the unit of electric current is.

13.- Student will distinguish, in 25 words or less, between conductors and insulators.

14.- He will in 2 to 3 sentences explain what is meant by (how electrical resistance occurs) electrical resistance and how its numerical value is related to the physical characteristics of conductors.

15.- Student will explain in 25 words or less, how the current in a conductor depends upon the properties of the conductor and the potential difference between its ends.

16.- The student will describe in 25 words or less how the concept of work enters into electric currents.

17.- He will explain in 25 words or less, the relationship between energy, work and power in electrical conductors.

18.- He will solve problems 1, 2, 3, 4, 9, 11, 12, 13, 14, 15 Van Name, Ch. 4.

19.- Without the use of the textbook, student will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items section of this unit.

UNIT 9 - MAGNETISM

Electric charges in motion produce forces which are considerably different from those existing when the charges are stationary. Forces that come into being when electric currents are brought near one another are called magnetic forces. The familiar "magnet" with its capability for attracting iron objects is shown to be but one aspect of the whole subject of magnetism, which more properly should be referred to, as electromagnetism.

Objectives

I. General The student will know the fundamental characteristics of magnetic phenomena.

Specific 1.-The student will in 100 words or less, give three examples of magnetic phenomena existing in his physical environment.

2.-The student will in 50 words or less, describe Oersted's experiment and what it demonstrated.

3.-He will draw a representation of a magnetic field using lines of force concept and explain in 25 words or less the significance of the direction of the lines and the spacing of the lines. He will be able to do this for three geometries; a bar magnet, a straight current carrying wire, and a loop current carrying wire.

4.-He will describe in 25 words or less magnetic induction and how it is used in defining the strength of a magnetic field.

5.-In 25 words or less, student should explain what is meant by magnetic flux.

II. General The student will know the principles used in calculating the value of the magnetic induction due to a current.

Specific 6.-The student will describe qualitatively in 50 words or less, the procedure used in deriving the Biot-Savart law and how it is used in determining the magnetic induction around any electric current.

7.-The student will state in 25 words or less the right hand rule for determining the direction of the magnetic field around a current carrying wire.

III. General The student will know the behavior of charged particles in magnetic fields.

Specific 8.-Given the equation for the force on a wire carrying a current in a magnetic field he will be able to derive the equation for the force on a charged particle in a magnetic field.

9.-He will in 50 words or less describe qualitatively the operating principle of the electric motor.

IV. General The student will know the principle of electromagnetic induction.

Specific 10.-The student will in 25 words or less, describe how electric fields can be produced by relative motion between a magnetic material and a wire loop.

11.-He will state, in one sentence, Faraday's law for electromagnetic induction and show by an equation how the potential difference generated in a wire loop is related to the time rate of change of the magnetic flux through it.

12.-The student will in 2 to 3 sentences describe electromotive force and the principles of electric generation.

13.-He will solve problems 18, 19, 20, 21, 22, 23, 49, 50, 51 - Van Name, Chapter 4.

14.-Without use of reference material, he will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items.

UNIT 10 - VIBRATIONS AND WAVES

The physical environment abounds with examples of waves and vibrating bodies; these two being similar in several essential respects. In both, a particular motion repeats itself at regular intervals, the motion representing the continuous conversion of potential energy to kinetic energy and back. An analysis of vibrations and waves is necessary to understand some obvious phenomena in our environment and is unseful in preparing us for an understanding of some of the leading problems in modern physics.

Objectives

I. General: The student will know the elements of simple elasticity.

Specific

1.-The student will, in one sentence for each term, state what is meant by tensile stress, compressive stress and shear stress and give one example of each in his physical environment.

2.-The student will, in one sentence, state Hooke's law and write the appropriate equation.

3.-The student will, in 25 words or less, define elastic limit and relate it to Hooke's law.

4.-Without the aid of any reference material, the student will derive the relationship between elastic potential energy and work for a body obeying Hooke's law.

II. General: The student will know the elements of simple harmonic motion.

Specific

5.-The student will, in 50 words or less, describe what is meant by simple harmonic motion.

6.-He will describe, in 50 words or less, how potential and kinetic energy interchange during oscillatory motion.

7.-The student will define the following terms which are basic to all oscillatory motion in one sentence for each term.

Period
Cycle
Frequency
Amplitude

8.-Starting with the equation for Newton's second law of motion, the student will derive the relationship between the period of a spring-mass system undergoing simple harmonic motion and the physical constants of the system.

9.-He will provide 3 examples from his physical environment of systems undergoing simple harmonic motion and distinguish in each example of Hooke's law force and the restoring force.

10.-The student will describe, in 50 words or less, how the motion of a simple pendulum can be used to determine the value of gravitational acceleration at different positions on the earth and on different planets in the solar system.

III. General The student will know the elements of wave motion and the relationship of wave motion to simple harmonic motion.

Specific 11.-He will, in 25 words or less, describe wave motion in terms of energy propagation through a medium.

12.-He will define the following terms, in 10 words or less for each term,

Frequency of wave
Wave length
Period of wave
Velocity of wave

13.-He will distinguish, in 50 words or less, longitudinal ~~logitudinal~~ waves from transverse waves and provide examples of each.

14.-He will solve problems 52, 53, 54, 55, 56, 57 - Chapter 2 - Van Name. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 14, 15, 16 - Chapter 5 - Van Name.

15.-Without the use of the text book, the student will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items section for this unit.

UNIT 11 - LIGHT

One other physical quality readily observant to our senses is light. Nineteenth century science was able to relate the phenomenon of light to electro-magnetic phenomena. Careful calculations showed that the speed of propagation of electro-magnetic waves and the speed of light, both in vacuum, were identical. This led to a consideration of the essential sameness of these two phenomena. This unit explores the relationship of light to electrical and magnetic phenomena which were studied in the previous two units.

Objectives

I. General The student will know the fundamentals of electromagnetic waves.

Specific 1.-The student will describe in 2 or 3 sentences how electromagnetic waves are produced.

2.-The student will explain in 25 words or less Maxwell's hypothesis with regards to generation of magnetic fields by electric fields and its significance in electromagnetic theory.

3.-The student will give 3 examples of electromagnetic waves and explain in 10 words or less how they differ.

II. General The student will know some of the experimental evidence supporting the wave theory of light.

Specific 4.-The student will distinguish in 10 words or less the particle theory from the wave theory of light.

5.-The student will, in 100 words or less, describe what refraction is and how it can be explained by both wave and particle theories of light, and why the former is correct.

6.-The student will state in 25 words or less what is meant by the index of refraction, and the relationship of the numerical value to the deflection of a light beam when entering or leaving a medium.

7.-The student will in 50 words or less describe what is meant by dispersion and explain light passage through a prism in terms of dispersion.

8.-The student will, in 50 words or less, explain diffraction phenomena and describe Young's double slit apparatus to support the wave theory of light.

9.-The student will in 50 words or less, state what the principle of superposition is andhow it explains interference phenomena.

10.—The student will describe in 2 or 3 sentences with accompanying diagram Young's double slit experiment to explain constructive and destructive interference.

III. General The student will understand the Polarization of waves.

Specific 11.—The student will in 50 words or less describe what is meant by polarization and how transverse and longitudinal waves can be distinguished.

12.—The student will describe an experiment, in 50 words or less, using the principle of polarization to establish the transverse wave characteristic of light.

13.—The students will solve problems 18, 19, 20, 38, 39 – Van Name – Chapter 5.

14.—Without the use of reference material, the student will solve 8 out of 10 problems (with 100% accuracy in 30 minutes) similar to those shown in Sample Test Items.

UNIT 12 - QUANTA

On one level of understanding, we can say that matter consists of atoms organized into molecules. A meaningful description of the constitutents of matter requires that we look into the structure of the atom. This involves looking into the sub-microscopic phenomena and the consideration of results of experiments which offer a startlingly different picture of the nature of physical reality.

Objectives

I. General: The student will become familiar with the electron as one of the fundamental particles in electrical phenomena.

Specific:

1.-The student will describe in 50 words or less what cathode rays are and the experimental evidence for cathode rays being electrical in nature.

2.-The student will describe in 50 words or less Thompson's experiment establishing the $\frac{e}{m}$ value of cathode ray particles.

3.-The student will describe, in 50 words or less, the experiment of Millikan to establish the basic charge of the electron.

II. General: The student will become familiar with the Black-Body Radiation problem.

Specific:

4.-The student will, in 50 words or less, define what is meant by black-body radiation and state the relationship between absorption and radiation.

5.-The student will be able to draw the black-body radiation curve showing its variation with temperature and wave length.

6.-The student will state in 50 words or less the relationship between temperature and radiation of a black-body as given in the Stefan-Boltzman Law and in Wien's Law.

7.-The student will explain in 100 words or less, Plancks postulate of quantization of energy to overcome the failure of classical physics in esplaining the black-body readiation curve.

III. General: The student will become acquainted with the fundamentals of photoelectric effect and understand it as background leading to the development of the quantum theory of light.

Specific:

8.-The student will describe in 10 words or less what the photoelectric effect is.

9.-The student will explain in 50 words or less 3 peculiarities of the photoelectric emission phenomena which shows that the electromagnetic theory of light cannot account for the photoelectric effect.

10.—The student will be able to draw the curve showing the variation in maximum photoelectron energy with frequency of incident light and from it, state in 10 words or less, what the significance of the threshold frequency is.

11.—The student will, in 10 words or less, define what is meant by quanta.

12.—The student will describe in 25 words or less, how the quantum theory of light satisfactorily accounts for the photoelectric effect.

IV. General The student will understand the nature of X-Rays and its relationship to quantum theory of light.

Specific 13.—The student will describe in 25 words or less, an experiment in which X-Rays are produced by impingment of electrons on a substance.

14.—The student will, in 10 words or less specify the evidence indicating that X-Rays are electromagnetic waves.

15.—The student will in 50 words or less, describe the physical process involved in the production of X-Rays.

V. General The student will understand the Compton effect.

Specific 16.—The student will describe an appropriate experiment in 100 words or less demonstrating the Compton effect and why it provides strong confirmation of the quantum theory of light.

VI. General The student will become acquainted with particle-wave duality nature of matter.

Specific 17.—The student will describe in 10 words or less, the hypothesis of Louis De Broglie with regards to the wave properties of particles.

18.—Without the textbook, the student will derive the De Broglie wavelength of a particle given the fundamental equation for the momentum of a photon.

19.—The student will, in 50 words or less, provide evidence supporting De Broglie's hypothesis.

20.—The student will, in 50 words or less, state what the uncertainty principle is, why it follows naturally from the wave nature of moving bodies and the particle nature of waves.

21.—The student will in 50 words or less, explain how the uncertainty principle affects the interpretation of physical laws and the formulas derived from them.

UNIT 13 - THE ATOM

It has been established that electrons are constituents of atoms and therefore electrical forces are significant in atomic phenomena. One of the earliest theories considered the atom with electrons embedded in a positively charged core. Subsequent work revealed the essential incorrectmess of this theory and the development of the more modern model of the atom using quantum theory.

Objectives

I. General — The student will become acquainted with the early concepts of atomic structure leading to the adoption of quantum theory in explanations of atomic behavior.

Specific

1.-The student will describe in 10 words or less, the Thomson model of the atom.

2.-The student will describe in 50 words or less, the Geiger-Marsden experiment and how the result leads to the rejection of the Thomson model and adoption of the nuclear model.

3.-The student will in 50 words or less specify the forces and the different energies involved to produce stable behavior in the nuclear model of the atom and describe how electomagnetic theory rules out the possibility for a stable atom to be achieved.

II. General — The student will know what emission and absorption spectra are and how they are related.

4.-The student will describe in 25 words or less continuous spectra and line spectra and explain how they are produced.

5.-The student will describe in 25 words or less what is meant by spectral series and give 3 examples obtained from the hydrogen atom and why this experimental data is important in the development of a "correct" theory of atomic structure.

III. General — The student will know the Bohr model of the atom and how it explains the observed hydrogen spectrum.

Specific

7.-The student will describe in 25 words or less the basic calculation made by Bohr relating the De Brolie wavelength of the electron to the pathlength of the electron orbit.

8.-The student will describe in 50 words or less what is meant by standing waves and how this concept was used by Bohr to explain the stable electron states.

9.--The student will be able to show in 25 words or less how the concept of stable electron orbits employing the principal of standing waves gave rise to quantum numbers.

10.--The student will in 25 words or less describe how the various possible electron orbits represent different energy levels.

11.--The student will in 50 words or less explain how an atom can become excited to higher energy levels and how the observed line spectrum from the hydrogen atom can be explained by the concept of atomic energy levels.

IV. General The student will know some fundamentals of the quantum theory of the atom.

Specific 12.--The student will state in 25 words or less three limitations of the Bohr theory.

13.--The student will in 50 words or less, describe the additional considerations advanced by the quantum theory to help explain spectra of more complex atoms and why this "newer theory" is better than the Bohr model.

14.--The student will solve problems 13, 14, 15, 17, 18, 19, 21, 22, Van Name, Chapter 6.

15.--Without the aid of reference material, the student will solve 8 out of 10 problems (in 30 minutes with 100% accuracy) similar to those shown in sample test item.

PHYSICS OBJECTIVES: SET #2

UNITS OF INSTRUCTION

The first unit of instruction is Rectilinear and Circular Motion and comprises a total of four weeks of instruction. The major concepts are the description of motion in terms of speed, velocity, acceleration, distance, and time; the first, second, and third laws of motion; the relationship between inertia and mass, force and motion, and mass and weight; friction; vector analysis; uniform circular motion; centripetal and centrifugal force; gravitation; and the gravitational field of the earth.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

speed, constant speed, instantaneous speed, average speed, velocity, scalar quantities, vector quantities, acceleration, acceleration of gravity, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion, force,inertia, mass, weight, friction, coefficient of friction, vectors, vector diagrams, uniform circular motion, centripetal acceleration, centripetal and centrifugal force, law of universal gravitation, gravitational field, and lines of force.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

A ________ is any influence that can cause a body to be accelerated.

What is the term which is described by the specification of both its speed and direction?

Write the formula which relates force to mass and acceleration.

Which of the following formulas describes the relationship between the force of friction and the coefficient of friction?

a) $F_f = \mu N$ c) $F_f = \frac{1}{\mu N}$

b) $F_f = \frac{\mu}{N}$ d) $F_f = \frac{N}{\mu}$

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

A mass of 8 kilograms and another of 12 kilograms are suspended by a string on either side of a pulley. What is the acceleration of the blocks?

In your own words, what is a vector quantity?

In a demonstration, it was noticed that a metal ball falls faster than a feather. Of what basic priciple is this an example?

On the application level, the student must be able to apply the principles learned to experiments performed or described by the instructor. An example is when the instructor exerts a force on a book lying on a table. When the force is small, the book does not move, however, as the force is increased, a point is reached when the book does move. Now what basic law is this an example of?

For analysis, the student should be able to state the reason why certain effects are noticed in the performance or description of experiments. For example, why does it take the same amount of time for a ball to be dropped four feet in an elevator when the elevator is stationary and when moving up or down? How must the elevator be moving for this to be true? to be false?

On the level of synthesis, various data will be given to the student from the performance of an experiment. He must be able to synthesize this data into a coherent law to which he may or may not be familiar. An example is given below:

The data listed below exemplifies a basic law of physics concerning force and motion. Synthesize this data into a mathematical formula and state the name of the basic law described.

Time in seconds	0	1	2	3	4	5	6
Distance traveled in time given (in meters)	0	$1\frac{1}{4}$	5	$11\frac{1}{4}$	20	$31\frac{1}{4}$	45
Velocity at time given (in meters per second)	0	$2\frac{1}{2}$	5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15

The second unit of instruction is Energy and Momentum and comprises a total of one and one half weeks of instruction. The major concepts are work, kinetic energy, potential energy, the conservation of energy, momentum, and the conservation of momentum. The application of these concepts comes in the process of collisions.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

work, energy, kinetic energy, potential energy, law of conservation of energy, linear momentum, impulse, and conservation of momentum.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

The product of force and its displacement is called ________.

If a body has the mass m and speed v, its kinetic energy is

a) $\frac{1}{2}mv^2$ c) mv^2

b) $\frac{1}{4}mv^2$ d) $\frac{1}{2}mv$

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

A force of 130 newtons is used to lift a 12 kilogram mass to a height of 8 meter. How much work is done by the force?

Define linear momentum, in your own words.

Besides being an example of the conservation of energy, billiards is an example of what other basic law?

On the application level, the student must be able to apply the principles learned to experiments performed or described by the instructor. For example, when a rocket ship takes off from its launching pad some material is exhausted from its pods at a high velocity and thus causing the rocket ship to rise. This is an example of what law in this unit?

On the analysis level, the student should be able to state the reasons of certain effects noticed in the performance or description of experiments. For example, when a bullet is fired from a gun, the gun recoils. What causes this?

On the synthesis level, various data will be given to the student from the performance of an experiment or the description of an experiment. He must be able to synthesize this data into a coherent law to which he may or may not be acquainted. For example, when measuring the kinetic and potential energies of a swinging pendulum, it is found that at one point the potential energy is zero and the kinetic energy is 25 joules. At a second point the potential energy is 10 joules and the kinetic energy is 15 joules. From this data, can we surmise anything about energy relationships?

The third unit of instruction is Vibrations and Waves and comprises a total of one and one half weeks of instruction. The major concepts are elastic potential energy, simple harmonic motion, waves, and the relationship between waves and simple harmonic motion.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

tension, compression, shear, Hooke's law, elastic limit, elastic potential energy, simple harmonic motion, period, frequency, amplitude, wave motion, longitudinal waves, and transverse waves.

The student must also be ~~albe~~ able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

The maximum displacement of a body on either ~~isde~~ side of its equilibrium position is called the ______________ of the body.

The frequency f and the period T are related by which of the formulas below?

a) $f = T$ c) $\frac{1}{f} = \frac{1}{T}$

b) $f = \frac{1}{T}$ d) $f^2 = \frac{1}{T}$

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

A coil spring has a force constant of 2 lb/ft. How much will it stretch when it is used to support an object whose mass is 0.5 slug?

State Hooke's law.

On the level of application, the student must be able to apply the principles learned to experiments performed or described b the instructor. For example, what is the basic principle behind the use of a pendulum clock?

For analysis, the student must be able to state the reason why certain effects are noticed in the performance or description of experiments. For example, it is seen that when a spring is stretched 10 cm it returns to its original length when released. However, when the spring is stretched to 11 cm it does not return to its original length. Why did this occur? What can be surmised about the elastic property of the spring?

On the level of synthesis, various data will be given to the student from the performance of an experiment. He must be able to synthesize this data into a coherent law to which he may or may not be familiar. For example, it is noted that when an object is floating on water, besides oscillating vertically as water waves pass beneath it, the object also oscillates horizontally. Question: Is this a different type of vibration than the types we have been considering? What type of vibration is it?

The fourth unit of instruction is Heat and Matter and comprises a total of two and one half weeks of instruction. The major concepts are temperature, heat, specific heat, change of state, pressure, the triple point, mechanical equivalent of heat, heat engines, matter in bulk, thermal expansion, Boyle's law, Charles' law, the ideal gas law, molecular theory of matter, kinetic theory of gases, molecular kinetic energy, and the kinetic theory of matter.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

> temperature, thermometer, celsius, fahrenheit, heat, kilocalorie, specific heat, heat of fusion, heat of vaporization, sublimation, pressure, critical point, triple point, mechanical equivalent of heat, first law of thermodynamics, second law of thermodynamics, solids, liquids, gases, plasmas, elements, compound, solution, coefficient of linear expansion, coefficient of thermal expansion, Boyle's law, Charles's law, absolute temperature scale, absolute zero, ideal gas law, molecules, atoms, kinetic theory of gases, and Brownian motion.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

> The __________ of a substance is the amount of heat required to change the temperature of 1 kg of water by $1^{\circ}C$.

> What law states that, at constant pressure, the volume of a sample of gas is directly proportional to its absolute temperature.

Express the following temperatures on the fahrenheit scale:

a) $100^{\circ}C$ b) $0^{\circ}C$ c) $50^{\circ}C$

What basic principle is the following formula derived from:

$pV = \text{constant}$

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

A rod 2 m long expands by 1 mm when heated from $8^{\circ}C$ to $72^{\circ}C$. What is the coefficient of linear expansion of the material from which the rod is made?

Restate the first law of thermodynamics in your own words.

In a demonstration, it was noticed that when two strips of metal (which were welded together) were heated, the composite strip was bent. What principle is this an example of?

On the application level, the student must be able to apply the principles learned to experiments performed or described by the instructor. As an example, kinetically speaking, why is the pressure exerted by a given amount of gas greater when the gas is heated than when it is cooled?

For analysis, the student should be able to state the reason why certain effects are noticed in the performance or description of experiments. For example, in one demonstration, three small balls made of different materials are heated to the same temperature and then placed in some parafin. The three balls sink into the parafin to different depths. Why did this occur?

On the level of synthesis, various data will be given to the student from the performance of an experiment. He must be able to synthesize this data into a coherent law to which he may or may not be familiar. The data listed below is found from measuring volume and temperature.

Volume (liters)	.5	1	2	3
Temperature (°K)	480	240	120	80

Derive a relationship between the volume and temperature when the pressure is held constant.

The fifth unit of instruction is Electricity and Magnetism and comprises a total of two and one half weeks of instruction. The major concepts are electric charge, Coulomb's law, the electric field, the electron, potential difference, electric current, energy and power, Oersted's experiment, magnetic induction, magnetic field of a current, magnetic properties of matter, charged particles, the cyclotron, electromagnetic induction, and the betatron.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge, level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

negative electric charge, positive electric charge, coulomb, Coulomb's law, electric field intensity, potential difference, electron volt, electric current, Ohm's law, resistance, ohm, power, watt, magnetic, lines of force, magnetic induction, Biot-Savart law, right-hand rule, paramagnetic, ferromagnetic, diamagnetic, permanent magnet, cyclotron, electromagnetic induction, magnetic flux, Lenz's law and betatron.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examplesof the type of questions are as follows:

The rate at which work is being done is called ________.

A wire 1 m long is perpendicular to a magnetic field of induction 5×10^{-2} weber/m^2, What is the force on the wire when it carries a current of 2 amp?

The forces that act between electric currents are called _______ forces.

Write Ohm's law in terms of mathematical symbols.

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

What is the radius of the path of a 4×10^4 ev electron in a magnetic field of 0.02 weber/m^2?

How does a cyclotron accelerate charged particles?

On the application level, the student must be able to apply the principles learned to experiments performed or described by the instructor. As an example, consider Coulomb's law which deals with electric forces. When is this law applicable? Why can't this law be used in the case of current carrying wires?

For analysis, the student should be able to state the reason why certain effects are noticed in the performance or description of experiments. For example, what causes two current carrying wires to attract each other?

On the level of synthesis, various data willbe given to the student from the performance of an experiment. He must be able to synthesize this data into a coherent law to which he may or may not be familiar. For example:

The data below has been taken from the measurement of work, force, and distance traveled by a charge in an electric field. Formulate an expression between these quantities from the data below:

Work (joules)	10	10	10
Force (newtons)	10	5	2
Distance (meters)	1	2	5

UNITS OF INSTRUCTION

The ~~fifth~~ sixth unit of instruction is Light and Modern Physics and comprises a total of five weeks of instruction. The major concepts are the relationship between electric and magnetic fields, electromagnetic waves and light, the speed of electromagnetic radiation through different materials, the principle of superposition, polarization, the relationship between the speed of light and the special theory of relativity, the quantum theory of light, the uncertainty principle, and the Rutherford and Bohr theories of the atom.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

Maxwell's hypothesis, electromagnetic waves, refraction, the index of refraction, dispersion, diffraction, the principle of superposition, constructive and destructive interference, polarized and unpolarized beams, the two postulates of the special theory of relativity, relativistic length contraction and time dilation, relativity of mass, rest energy, the photoelectric effect, the quantum theory of light, quanta or photons, the Compton effect, de Broglie waves, the uncertainty principle, the Rutherford and Bohr theory of the atoms, emission and absorption, spectrums, continuous spectrum, bright and dark line spectrums, spectral series, energy levels of an atom, and the quantum theory of the atom.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

The ability for waves to bend around the edges of objects in their paths is called __________.

What is the name of the process when electrons are emitted from a metal surface when light is shined on it?

How fast would a rocket ship have to go for each year on the ship to correspond to two years on the earth? This problem would be similar to one which is done in class, and is simply the application of the same formula.

What basic principle is the following formula derived from?

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

What is the relativistic contraction of a rocketship 100 feet long when it moves away from an observer at a rate of 1000 miles/hour?

Describe in your own words the effect Michelson and Morley observed in their experiment to measure the change in the speed of light.

In a demonstration, it was noticed that when light is passed through two transparent pieces of glass, the intensity increases and decreases as one of the pieces of glass is rotated. What principle is this an example of?

On the application level, the student must be able to apply the principles learned to experiments described or performed by the instructor. For example, the instructor is performing an experiment in optics, and states that he sees light and dark lines, and that the light lines are 1 millimeter apart. He also says that the distance from the screen with light and dark lines to the face of a "black box" is 1 meter. Question: What experiment is being described by the instructor and what are the two most important items in the black box which give rise to the described pattern? What are the sizes of each?

For analysis, the student should be able to state the reason why certain effects are noticed in the performance and description of experiments, as far as the course material has developed. For example, quantum theory states that all waves behave also like objects and that all objects behave also like waves. Why is it then, that a ball is not observed to have the properties of a wave? (This question, on the analysis level, assumes that the instructor has not specifically solved problems for the class on the wave nature of "large" objects, but assumes that the student will be able to calculate this effect and its magnitude.)

On the synthesis level, various data will be given to the student from the performance of an experiment. He must be able to synthesize this data into a coherent law, to which he may or may not be familiar. This is an extension of the scientific method into the unit of instruction: Light and Modern Physics. For example, an experimenter notices that when light is shined on an electrode, a current flows through the circuit to which the electrode is connected. As the intensity of the light is increased, the current increases until it reaches a certain point, then remains constant. A battery is now inserted into the circuit with its polarity in such a direction as to ordinarily inhibit the flow of current. Light is again shined on the electrode and a current is again observed to flow. Question: 1) list the observed phenomena. 2) from these phenomena and your knowledge of the quantum nature of light, write what you think is causing the current flow.

The seventh unit of instruction is Nuclear Physics and comprises a total of one and one half weeks of instruction. The major concepts are nucleons, isotopes, nuclear binding energy, radioactivity, the neutrino, nuclear reactions, nuclear forces, elementary particles, and antiparticles.

Upon completion of this unit, the student should be able to score a minimum of 75% on each of the following levels of instruction.

On the knowledge level, the student should be able to define and explain the following terms and concepts as part of a fill-in type, multiple-choice, true-false, or completion of statement examination:

atomic number, neutron, nucleons, mass number, isotopes, atomic mass mass units, binding energy, fusion, fission, radioactive, alpha particles, beta particles, gamma rays, positrons, half-life, neutrino, antiproton, annihilate, and elementary particles.

The student must be able to solve problems which are applications of formulas presented in the book and in lecture. In addition, the student must be able to state basic laws in terms of mathematical symbols and interpret mathematical symbols as physical laws. Examples of the type of questions are as follows:

The time required for half a given sample of radioactive substance to decay is called its ___________.

What are the three types of radioactive emissions?

State the number of neutrons and protons in each of the following nuclei:

$_{3}Li^{6}$; $_{6}C^{13}$; $_{15}P^{31}$; $_{40}Zr^{94}$; $_{56}Ba^{137}$

Neutrons and protons are jointly called _____________.

On the comprehension level, the student must be able to choose the correct formulas to use in the solution of numerical problems. He must be able to describe in his own words the basic concepts which were previously listed. He must also be well enough acquainted with the material so that he will be able to state the law or laws which exemplify a demonstration. Typical examples are:

What is the minimum energy a gamma-ray photon must have if it is to split an alpha particle into (a) a triton and a proton, and (b) a helium-3 nucleus and a neutron?

The atom bomb is an example of what type of nuclear process?

On the application level, the student must be able to apply the principles learned to experiments performed or described by the instructor. For example, the hydrogen bomb consists mainly of "heavy" hydrogen. In order for energy to be released, what must happen to this "heavy" hydrogen?

For analysis, the student should be able to state the reason why certain effects are noticed in the performance or description of experiments. For example, when taking geiger counter readings on a piece of radioactive material, it is found that over two weeks, the readings have not decreased. What can be said about the half life of this radioactive material?